U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-272 030

Machinery Noise and Exposed Machine Operators in the Fabricated Metal Products Industry (SIC 34)

IIT Research Inst, Chicago, Ill

Prepared for

Environmental Protection Agency, Washington, D C

Jul 75

Peter G. Schessler

PB 272 030

July 1975

MACHINERY NOISE AND EXPOSED MACHINE OPERATORS IN THE FABRICATED METAL PRODUCTS INDUSTRY (SIC 34)

Task Report J9131

By

E. B. Ahlers
E. P. Bergmann

Contract 68-01-2234

Project Officer
E. Berkau

Prepared for
Environmental Protection Agency
4th and M Streets, S.W.
Washington, D.C. 20460

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1 REPORT NO	2	3 RECIPIENT'S ACCESSION NO
4 TITLE AND SUBTITLE Machinery Noise and Exposed Machine Operators in the Fabricated Metal Products Industry (SIC 34)		5 REPORT DATE July 1975 6 PERFORMING ORGANIZATION CODE
7 AUTHOR(S) E.B. Ahlers, G.P. Bergmann		8 PERFORMING ORGANIZATION REPORT NO
9 PERFORMING ORGANIZATION NAME AND ADDRESS IIT Research Institute 10 West 35th Street Chicago, Illinois 60616		10 PROGRAM ELEMENT NO 11 CONTRACT/GRANT NO EPA 68-01-2234
12 SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Noise Abatement and Control 401 M Street, S.W. Washington, D.C. 20460		13 TYPE OF REPORT AND PERIOD COVERED Interim 14 SPONSORING AGENCY CODE

15 SUPPLEMENTARY NOTES

16 ABSTRACT

This document entitled "Machinery Noise and Exposed Machine Operators in the Fabricated Metal Products Industry (SIC 34)", is a task report. Effort was directed toward the identification of machines, noise levels and numbers of workers exposed in the fabricated metal products industry.

This report was submitted in partial fulfillment of Project Number J6131, Contract Number 68-01-2234, by IIT Research Institute, under sponsorship of the Environmental Protection Agency. Work was completed as of July 1975.

17 KEY WORDS AND DOCUMENT ANALYSIS

a DESCRIPTORS	b IDENTIFIERS/OPEN ENDED TERMS	c COSATI Field/Group

18 DISTRIBUTION STATEMENT	19 SECURITY CLASS (This Report) Unclassified	21 NO OF PAGES 74
Release Unlimited	20 SECURITY CLASS (This page) Unclassified	22 PRICE NCA - A01

EPA Form 2220-1 (9-73)

ATTENTION

AS NOTED IN THE NTIS ANNOUNCEMENT,
PORTIONS OF THIS REPORT ARE NOT LEGIBLE.
HOWEVER, IT IS THE BEST REPRODUCTION
AVAILABLE FROM THE COPY SENT TO NTIS.

DIRECT QUESTIONS RESULTING FROM ILLEGIBILITY TO:

MR. JOHN DIGNAN
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
401 M STREET, S.W.
WASHINGTON, D.C. 20460

DISCLAIMER

This report has been reviewed by the U.S. Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

This document entitled "Machinery Noise and Exposed Machine Operators in the Fabricated Metal Products Industry (SIC 34)", is a task report. Effort was directed toward the identification of machines, noise levels and numbers of workers exposed in the fabricated metal products industry.

This report was submitted in partial fulfillment of Project Number J6131, Contract Number 68-01-1234, by IIT Research Institute, under sponsorship of the Environmental Protection Agency. Work was completed as of July 1975.

CONTENTS

		Page
Abstract		ii
List of Tables		iv
Acknowledgments		vi
Sections		
I	Conclusions	1
II	Recommendations	2
III	Introduction	3
IV	Summary	5
V	Machine Noise Levels	15
VI	Numbers of Machine Tools	21
VII	Numbers of Machine Tool Operators	25
VIII	Ranking and Prioritizing	36
IX	REFERENCES	40
	Appendix: Industry Machine Noise Level Data	43

TABLES

		Page
1	Machine Operator Exposure in Fabricated Metal Products Industry 1973 (96 dBA and above)	7
2	Machine Operator Exposure in Fabricated Metal Products Industry 1973 (91 to 95 dBA)	8
3	Machine Operator Exposure in Fabricated Metal Products Industry 1973 (86 to 90 dBA)	9
4	Machine Operator Exposure in Fabricated Metal Products Industry 1973 (85 dBA and under)	9
5	Machine Tools with Unidentified Noise Levels	10
6	Ranking of Machine Tools and Equipment by Selected Noise Exposure Criteria	12
7	Age of Machine Tools in Fabricated Metal Products Industry 1968 and 1973	14
8	Metal Cutting Machine Noise Levels	16
9	Metal Forming Machine Noise Levels	18
10	Joining Equipment Noise Levels	19
11	Other Equipment Noise Levels	20
12	Metal Cutting Machine Tools, Fabricated Metal Products Industry 1968 and 1973	22
13	Metal Forming Machine Tools, Fabricated Metal Products Industry 1968 and 1973	23
14	Joining Equipment, Fabricated Metal Products Industry 1968 and 1973	24
15	Other Equipment, Fabricated Metal Products Industry 1968 and 1973	24
16	Estimated Number of Operators -- Metal Cutting Machines	27
17	Estimated Number of Operators -- Metal Forming Machines	28
18	Estimated Number of Operators -- Joining and Other Equipment	29

TABLES (concluded)

		Page
19	1971 Occupational Statistics on Fabricated Metal Products Industry	30
20	Distribution of Numerically Controlled Machines	31
21	Distribution of BLS Occupational Survey Designated Occupations Among Skill Levels	32
22	Ratios of Machine Operators to Others at Various BLS All Other Skill Levels	34
23	Allocation of BLS All Other Skilled, Semiskilled, and Unskilled Between Machine Operator and Nonoperator Occupations	35
24	Machines Ranked by Suprathreshold-Weighted Number of Operators	37
25	Machines Ranked by Relative Intensity-Weighted Number of Operators	38
26	Machine Tools Ranked by Decibel-Weighted Number of Operators	39

ACKNOWLEDGMENTS

IIT Research Institute staff members that contributed to this task were E. R. Ahlers and E. P. Bergmann.

Technical guidance and assistance were provided by Dr. E. Berkau and S. Cordle of the Environmental Protection Agency.

SECTION I

CONCLUSIONS

It is concluded that:

- Of 838,000 production workers in the fabricated metal products industry, 442,000 (53 percent) are machine operators exposed to noise levels above 85 dBA, 387,000 (46 percent) above 90 dBA, and 269,000 (32 percent) above 95 dBA.

- The age distribution of machines in the industry indicates that long lead times will occur beyond the date of availability of quiet machines to achieve any substantial reduction in the number of exposed operators solely by normal machine replacements.

SECTION II

RECOMMENDATIONS

It is recommended that:

- An index consisting of the product of the number of exposed machine operators and the incremental machine noise level above a selected threshold be used as a criterion for prioritising machine tools for consideration as industrial noise problems. Expressed mathematically

$$\frac{N_p \cdot [dBA_m - 85]}{1000}$$

where

N_p = number of machine operators

dBA_m = machine noise level measured at operator position

- Studies similar to that reported herein be conducted for all other industries, starting with the most noise intensive industries.

SECTION III

INTRODUCTION

The objectives of this effort were to:

- Identify all machinery sources of noise in the fabricated metal products industry. The task report of 15 November 1974, Severe Sources of Industrial Machinery Noise, serves as the basis for the identification of machines. Additional machines will be added if found.
- Determine typical machine noise levels.
- Group machines by common functions.
- Prioritize machines within groups.

The accomplishments of this study include:

- Data on machine types and numbers of machines were obtained from the American Machinist Inventory of Metalworking Equipment.
- Noise levels of machines were obtained from OSHA files, NOISE files and from articles and papers in the open literature. Noise levels were distributed over the machine types and industries. The compilation of the machinery noise levels is included as an appendix to this report.
- Data on the numbers of machine operators of each class of machine were obtained from Bureau of Labor Statistics reports. These data were distributed over the machine types. Machine types, number of workers exposed, and machine functions served as bases for grouping, ranking and prioritizing the machines within the industry.

Emphasizing the exposure of machine tool operators to machine noise, identifies the primary exposed population -- that of workers whose normal occupational duties are performed in proximity to the machine for the greatest

portion of the work period. Exposed populations thus do not include all noise exposed workers in the industry. There are in addition, nonmachine operators normally exposed to area noise levels which may be less than individual machine levels and workers whose occupations lead to intermittent exposures to area and machine noise levels. Examples of these latter types of industrial workers are machine setup men, materials handlers, inspectors and foremen.

Concerted efforts were made to use the most applicable and reliable of available statistics for estimating purposes. These included the 10th and 11th American Machinist Inventory of Metalworking Equipment of 1968 and 1973 (McGraw-Hill), for data on numbers of machine tools in use, and the Bureau of Labor Statistics 1971 Occupational Survey for data on numbers of workers in various occupations. Computational treatment was introduced to allocate workers to machine tools in cases where occupational survey data were presented in broader or general categories than the more detailed machine tool inventory. These practices are explained in the text. Noise level data for machine tools were obtained from OSHA records, the open literature, and the Karplus-Konvalies survey of noise in manufacturing industries.

Data are also presented on the age distribution of machine tools. Particularly long lead times are required beyond the date and availability of quiet machines to achieve any substantial reduction in the numbers of exposed operators solely by normal machine replacement. Age distribution of machine tools in the industry in 1973 was approximately 30-40-30 percent in age groups under 10 years, 10 to 20 years and over 20 years, respectively. Without significant change in replacement practices one could expect comparable reductions in the number of exposed operators in future time periods of the same durations.

SECTION IV

SUMMARY

The number of machine operators in the fabricated metal products industry exposed to various noise levels at the operator position, together with the number of machines involved for 1973 is estimated to be:

Noise Level dBA	Number of Machines	Number of Operators	Percent of 838,080 Total Production Workers
85 and under	1,986	1,301	-
86 to 90	108,968	54,831	7
91 to 95	211,792	118,531	14
96 and over	403,324	268,622	32

Cumulative numbers of machines and operators above selected noise levels is estimated to be:

Noise Level dBA	Number of Machines	Cumulative Number of Operators	Percent of 838,080 Total Production Workers
96 and above	403,324	268,622	32
91 and above	615,116	387,143	46
86 and above	724,084	441,974	53

The above tabulation lists machine operators specifically and does not include other workers exposed to area noise levels in the shops. These estimates were based on data from:

- Noise level data for machines from OSHA records, open literature, and the Harpius-Bonvallet study of machine noise levels in manufacturing industries (Reference 1)

- Numbers of machines from the American Machinist inventory of metalworking equipment (References 2 and 3)

- Numbers of machine operators and other production employees from Bureau of Labor Statistics occupational survey (References 4 through 12).

These clarifications are made regarding the estimate of the exposed population: (1) the "exposed workers" is an estimate of the number of operators of machines reported to have exposures, measured at operator's position, at levels indicated; (2) reasonable assumptions were applied in relating occupational statistics to machine inventory statistics and noise level data; (3) no attempt was made to include nonoperators of machines such as material handlers, machine setup men, maintenance and repair personnel, etc.; (4) no adjustments were made for data entries marked not available (n.a.) in accordance with the three-number rule, among BLS occupational statistics used in developing the exposed population estimate; and (5) no inclusions are made in the summary statistics for machines for which specific decibel levels were not reported or for the operators thereof. Items (3), (4) and (5) tend to make the exposed population estimate conservative.

Machine tools are ranked in 5 dBA incremental noise groups in Tables 1 through 5:

Table	Subject
1	Machines, 96 dBA and above
2	Machines, 91-95 dBA
3	Machines, 86-90 dBA
4	Machines, 85 dBA and below
5	Machines, dBA level not available

Noise levels listed for the machines in these tables are arithmetic mean values of reported dBA levels in the aforementioned sources. In each table the machines are grouped by primary class (metal cutting, metal forming, joining and other equipment) and ranked according to dBA level. Estimated numbers of machines and exposed operators are also listed.

Table 1. MACHINE OPERATOR EXPOSURE IN FABRICATED METAL PRODUCTS INDUSTRY 1973 (90 dBA and above)

Machine Type	Noise Level dBA	Number of Machines	Number of Operators
Metal Cutting Machines			
Circular Saws (Cold)	110	7,859	3,799
Planing Machines	110	1,293	573
Hacksaws, Cutoff Saws	107	8,984	3,300
"Other" Saws, (including Friction)	107	2,409	858
Abrasive Wheels	105	6,365	2,339
Bench, Floor & Snag Grinders	100	20,412	10,604
Shaping Machines	99	6,361	2,041
Bandsaws, Contour Sawing & Filing Machines	97	20,003	8,264
Milling Machines	96	35,711	15,997
Tool & Cutter Grinders	96	7,451	3,259
Metal Forming Machines			
Riveting Machines (Squeeze Type)	118	6,523	5,263
Riveting Machines (except Squeeze Type)	115	6,785	3,863
Forging Hammers	114	2,031	1,406
Rolls & Swagers	113	1,241	774
Press Brakes	111	16,924	15,902
Shearing Machines	105	13,849	10,506
Forging Presses	103	1,328	3,986
Headers	101	9,666	3,849
Hydraulic & Pneumatic Presses	101	11,006	3,594
Wire & Metal Ribbon Formers, (Press Type)	101	4,141	1,087
Mechanical Power Presses	99	121,087	103,812
Joining Equipment			
Metallizing Equipment (Gas & Plasma)	102	1,484	321
Manual Arcwelding Equipment	97	90,213	59,528
TOTAL		403,324	288,622

Table 3. MACHINE OPERATOR EXPOSURE IN FABRICATED METAL PRODUCTS INDUSTRY 1973 (91 to 95 dBA)

Machine Type	Noise Level dBA	Number of Machines	Number of Operators
Metal Cutting Machines			
Drilling Machines	95	75,321	41,254
Automatic Bar (Screw) Machines	95	30,730	17,455
Polishing & Buffing Machines	95	22,295	9,313
Turret Lathes	95	13,296	8,418
Tapping Machines	94	10,240	3,698
Boring Machines	94	3,521	1,958
Special Way Type & Transfer Machines	94	2,017	842
Vertical Turning & Boring Mills	93	2,088	1,321
Metal Forming Machines			
Wire & Metal Ribbon Formers (except Presses)	95	5,594	1,469
Bending Rolls	92	9,777	6,392
Joining Equipment			
Electric Resistance Welding Equipment	94	31,685	22,615
Flame Cutting Machines	92	5,238	3,744
TOTAL		211,792	118,521

Table 3. MACHINE OPERATOR EXPOSURE IN FABRICATED METAL PRODUCTS INDUSTRY 1973 (86 to 90 dBA)

Machine Type	Noise Level dBA	Number of Machines	Number of Operators
Metal Cutting Machines			
Production Type Grinders	90	53,029	27,549
Automatic Chucking Lathes	90	3,794	2,376
Engine & Toolroom Lathes	89	37,250	20,074
Threading Machines	89	6,435	3,324
Tracer Lathes	88	827	504
Metal Forming Machines			
Thread Rolling Machines	89	7,633	2,004
TOTAL		108,968	54,831

Table 4. MACHINE OPERATOR EXPOSURE IN FABRICATED METAL PRODUCTS INDUSTRY 1973 (85 dBA and under)

Machine Type	Noise Level dBA	Number of Machines	Number of Operators
Metal Cutting Machines			
Gear Cutting Machines	84	1,017	326
Other Equipment			
Diecasting Machines	80	969	975
TOTAL		1,986	1,301

Table 5. MACHINE TOOLS WITH UNIDENTIFIED NOISE LEVELS

Metal Cutting Machines

- Multifunction Machines (Mill-Drill-Bore)
- Automatic Assembly Machines
- Broaching Machines
- Honing Machines
- Lapping Machines
- Gear Cutting Machines (Hobs, Form Mill, Cutters)
- Gear Tooth Finishers
- Electrical Machining Units
  - Electrical Discharge Machines (EDM)
  - Electrochemical Machines (ECM)
  - Electrolytic Grinders (ELG or ECG)

Metal Forming Machines

- Rotary Bending and Forming Machines
- Punching Machines
- Marking Machines
- Roll Forming Machines

Joining Equipment

- Semiautomatic & Automatic Electric Arcwelding Equipment
- Gas Welding & Brazing Equipment
- Brazing Machines (Induction & Resistance)

Other Equipment

- Plastic Molding Machines
- Inspection & Measuring Equipment
- Heat Treating Equipment
- Baking and Drying Ovens
- Cleaning & Finishing Equipment

The number of machines is two or three times that of operators in many cases. This may be attributed to two considerations: (1) the nature of the industry, and (2) disparity between levels of detail in the machine tool inventory and occupational survey data used in developing the above estimates.

Regarding the nature of the industry, it is recognized that most of the companies do not have operations in which all machines are manned and operating continuously. One man may operate more than one machine. Production lines may be operated alternately. Many are job shop operations with attendant variability in operator assignments. Regarding the survey data occupational statistics were collected on a sampling basis and operator categories were much broader than machine inventory categories. The 1971 occupational survey was the first one conducted and respondents reporting this information for the first time and associating the data items with their individual shop structure and operating practices may have introduced interpretation problems.

Machines were ranked according to three ranking systems to prioritize them for consideration as industrial noise problems in the fabricated metal products industry. (1) The product of the number of exposed operators (N_p) and the incremental noise emitted above 85 dBA, i.e., $N_p \cdot (dBA - 85)$. This mode of prioritizing appears to have most merit since the degree of hearing loss is generally regarded to vary linearly with noise level. (2) The product of the number of exposed workers and noise intensity factor (F_n) which doubles with each 3 dBA increment in noise level. In this case 86 dBA was given an intensity index value of 1.00. This system recognizes intensity as a causal factor in noise induced hearing loss. (3) The product of the number of exposed operators and machine noise level, i.e., $N_p \cdot dBA$. Results of these rankings are presented in Table 6.

The distribution of machine tools in broad age-group classes in the fabricated metal products industry for 1968 and 1973 is presented in Table 7. More than two-thirds of the machine tools are over 10 years old and more than one-fourth are over 20 years old. This distribution is pertinent to noise considerations and this report because: machine tool noise increases with machine age; intensive effort on noise reduction in machine tool design is a relatively recent development; it provides justification

Table 6. RANKING OF MACHINE TOOLS AND EQUIPMENT BY SELECTED NOISE EXPOSURE CRITERIA

Type of Machine Tool or Equipment	Rankings					
	L_p(dBa-8H)		(T_e - L_p)/3000		(L_p - 85)/3000	
	Rank	Index Value	Rank	Index Value	Rank	Index Value
Mechanical Presses (except Forging)	1	1,438.4	2	2,872.7	1	10,178.4
Electric Arcwelding Equipment	2	836.6	5	1,358.7	2	6,980.4
Bending & Forming Machines (Power)	3	485.3	4	1,634.7	6	2,629.3
Punching & Shearing Machines (Power)	4	471.2	3	1,889.1	7	2,477.8
Drilling Machines	5	412.5	8	330.8	5	3,859.1
Grinding Machines	6	338.8	9	213.8	4	3,929.5
Turning Machines	7	358.6	10	205.5	3	4,726.8
Cutoff, Sawing & Filing Machines	8	304.3	6	897.8	9	1,798.4
Riveting Machines	9	282.8	1	23,774.4	11	1,867.7
Electric Resistance Welding Equipment	10	203.9	23	143.9	8	2,229.6
Milling Machines	11	176.8	11	182.2	10	1,535.7
Forging Machines	12	158.5	7	888.4	12	1,842.2
Polishing & Buffing Machines	13	93.1	15	74.5	13	884.7
Hydraulic & Pneumatic Presses (except Forging)	14	57.5	14	115.8	15	383.8
Tapping Machines	15	33.3	20	23.5	16	347.6
Wire & Metal Ribbon Formers	16	33.2	17	48.9	18	258.5
Shaping Machines	17	28.6	16	62.1	19	202.1
Flame Cutting Machines	18	26.2	19	25.8	17	344.4
Boring Machines	19	17.6	21	12.4	21	196.1
Other Metal Forming Machines (Ball Forming, etc.)	20	16.8	22	9.8	14	399.6

Table 6 (concluded). [illegible]

Type of Machine Tool or Equipment	Rankings					
	[illegible]		[illegible]		[illegible]	
	Rank	Index Value	Rank	Index Value	Rank	Index Value
Planing Machines	21	14.3	22	146.7	24	63.0
Threading Machines	22	9.3	24	4.6	28	205.8
Special Way Type & Transfer Machines	23	7.6	23	5.3	22	76.1
Metallizing Equipment	24	5.5	20	13.8	25	32.6
Gear Cutting & Finishing Machines	25	-8.3	26	8.2	26	29.2
Diecasting Machines	26	-4.9	25	8.2	23	78.8

for using data from the Karplus-Bonvallet 1953 survey in developing estimates used in this report, since the 1953-1963 period (and later) was not an era of intense effort to substantially reduce noise in new machine tools; it provides justification for using OSHA records in selecting machine tool noise levels, which otherwise might be criticized on the basis of being unusual complaint cases.

Table 7. AGE OF MACHINE TOOLS IN FABRICATED METAL PRODUCTS INDUSTRY 1968 and 1973

Machine Type	Number of Machines		
	Over 20 yrs (percent)	10-20 yrs (percent)	Under 10 yrs (percent)
Metal Cutting			
1973	27	40	33
1968	22	41	37
Metal Forming			
1973	31	41	28
1968	24	43	33

SECTION V

MACHINE NOISE LEVELS

Machine noise levels are summarized in tables:

Table 8 Metal Cutting Machines
Table 9 Metal Forming Machines
Table 10 Joining Equipment
Table 11 Other Equipment

Machines in each class are categorized essentially to the narrowest degree to which machines are defined in the American Machinist Inventory of Metalworking Equipment and for which noise levels were reported. Thus seven types of turning machines are listed while drilling machines are listed only as a general class. Where ranges were reported in the open literature they are identified in these tables by inclusion in parentheses. Both limits of the ranges were justifiably included in computations of arithmetic mean values since at least two machines are represented.

Individual reported noise levels and the arithmetic mean value of all reported measurements are listed for each category of machine.

Table 8. [illegible]

Machine Type	Reported Noise Levels (dBA)			Arithmetic Mean Value (dBA)
	Kamplus-Bonneville Study*	Open Literature	OSHA Records	
Turning Machines		(80-95)		
Engine and Tool Room Lathes	89,90			89
Tracer Lathes	88			88
Turret Lathes	107,88,84,94			95
Automatic Chucking Lathes	90			90
Automatic Bar (Screw) Machines	91,85,95	(90-105),97	(88-98)	95
Vertical Turning and Boring Mills	85		711,83	93
Other Types				
Boring Machines	97,96		90-97	94
Drilling Machines	90,88,86,96	114		95
Milling Machines	89,88	(88-98),118	(94-104)	96
Multifunction Machines (Drill-Mill-Bore)				
Special Way Type and Transfer Machines			94	94
Automatic Assembly Machines				
Tapping Machines	94			94
Threading Machines (Mill-Grind-Roll)	89 (Roll)			89
Broaching Machines				
Planing Machines		(110-115)	(105-110)	110
Shaping Machines	93		(140-185)	99

*Octave band measurements originally reported by Kamplus-Bonneville (Ref. 1) were converted to dBA.

Table 4 (concluded). METAL CUTTING MACHINE NOISE LEVELS

Machine Type	Reported Noise Levels (dBA)			Arithmetic Mean Value (dBA)
	Kamplan-Hanvaillet Study	Open Literature	OSHA Records	
Cutoff, Sawing and Filing Machines				
Bandsaws, Contour Sawing and Filing Machines		(98-105)		97
Abrasive Wheels	105			105
Circular Saws (Cold)		(105-116)		110
Others (Including Friction)	107			107
Bandsaws, Cutoff Saws		(96)	103,122	107
Grinding Machines				98
Bench, Floor and Snag	93,105	(95-104),96	105	100
Tool and Cutter Grinders	98 (Ben)			96
All Others (Mostly Production Types)	85,86,94,55, 96,87	(80-95)		90
Honing Machines				
Lapping Machines				
Polishing and Buffing Machines	95	(90-102)		95
Gear Cutting and Finishing Machines				
Cutting Types (Hobs, Shapers, Form Mills, Cutters)	84 (Shaper)			84
Gear Tooth Finishers (Grind, Lap, Hone, etc.)				
Others				
Electrical Machining Sets				
Electrical Discharge Machines (EDM)				
Electrochemical Machines (ECM)				
Electrolytic Grinders (EGC or ECG)				
Other Metal Cutting Machines				

[illegible]

Table 10. WELDING EQUIPMENT NOISE LEVELS

Equipment Type	Reported Noise Levels (dBA)			Arithmetic Mean Value (dBA)
	Kaplan-Hannaillet Study*	Open Literature	OSHA Records	
Electric Arcwelding Equipment				
Manual Semiautomatic and Automatic Machines	82,112			97
Electric Resistance Welding Equipment (Spot, Projection, Butt, etc.)	90		(85-97)	94
Gas Welding or Brazing Machines				
Flame Cutting Machines	92	91 (Scarfing)		92
Metallizing Equipment (Gas and Plasma)		(104-105) (Plasma)	(104-107)	102
Brazing Machines (Induction and Resistance)				

*Octave band measurements originally reported by Kaplan-Hannaillet (Reference 1) were converted to dBA.

Table II. [illegible]

Equipment Type	Reported Noise Levels (dBA)			Arithmetic Mean Value (dBA)
	Kenyon Bonneville Study	Noise Literature	OSHA Records	
Plastics-Molding Machines				
Precasting Machines (Hot and Cold Chamber)		(75-85)		80
Inspection and Measuring Machines				
Heat Treating Equipment				
Baking and Drying Ovens				
Cleaning and Finishing Equipment				

SECTION VI

NUMBERS OF MACHINE TOOLS

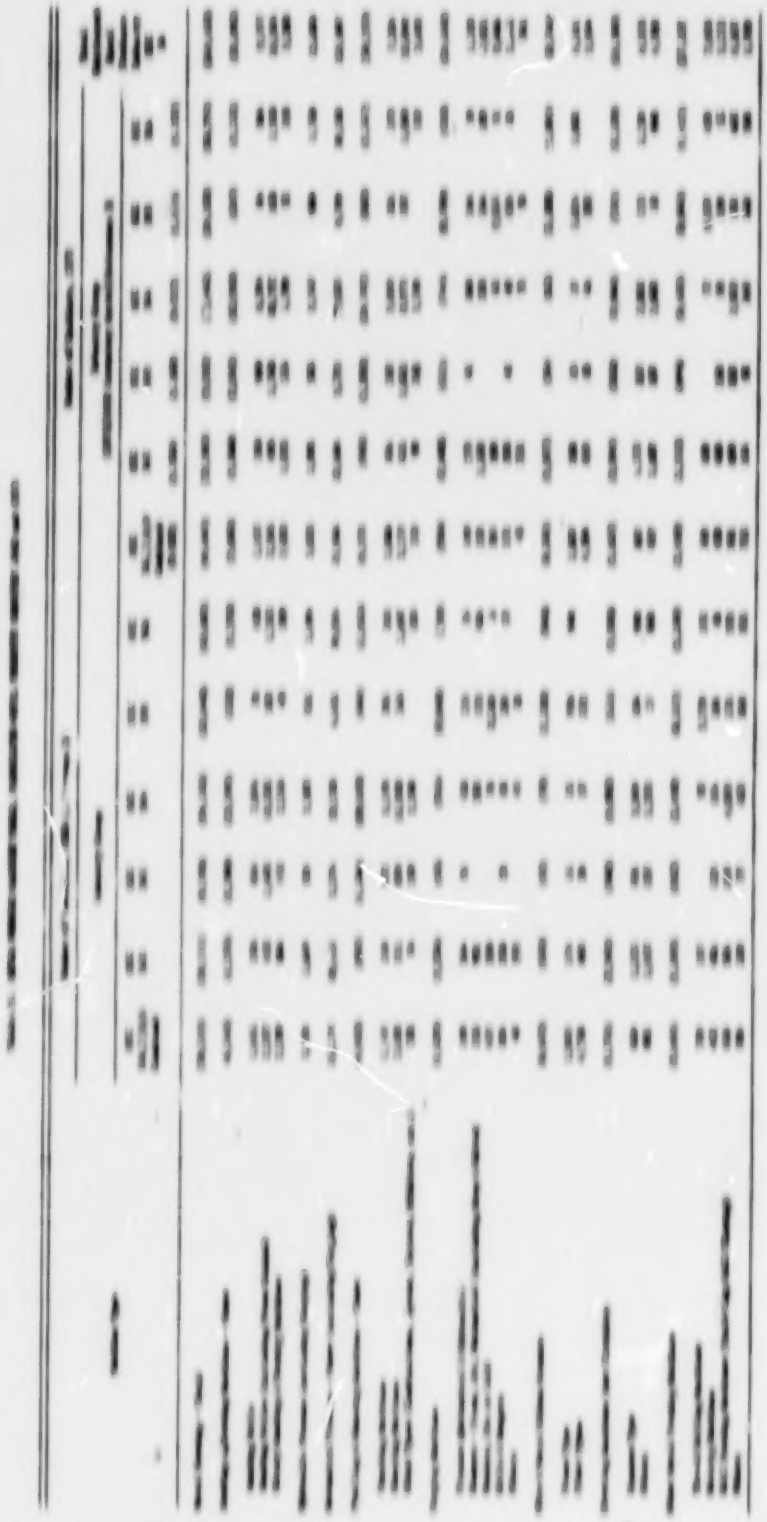
Estimated total numbers of machine tools of each type are listed in Tables 12 through 15 along with tabulated data depicting the development of the estimate according to these procedures:

- Listing machine tools of each type for the various three-digit industry groups within the fabricated metal products industry as reported in the 1968 American Machinist Inventory of Metalworking Equipment (Reference 2)
- Listing 1968-1973 inventory ratios as reported in the 1973 American Machinist Inventory of Metalworking Equipment (Reference 3) for the three-digit industry groups for metal cutting machinery, metal forming equipment, and joining and other equipment for which class A-weighted averages of the aforementioned two ratios were used.
- Extrapolating 1968 inventory figures to the year 1973 for each machine type and each three-digit industry group
- Summing 1973 estimated inventory figures for three-digit industry groups.

Numbers in parentheses in Tables 12 through 15 are subtotals and totals.

Three-digit industry groups within the fabricated metal products industry are:

SIC 341: Metal Cans Industry
SIC 342: Cutlery, Hand Tools and Hardware Industry
SIC 343: Plumbing and Heating, except Electric, Industry
SIC 344: Fabricated Structural Metal Products Industry
SIC 345: Screw Machine Products Industry
SIC 346: Metal Stampings Industry
SIC 347: Coating, Engraving and Allied Services Industry
SIC 348: Miscellaneous Fabricated Wire Products Industry
SIC 349: Miscellaneous Fabricated Metal Products Industry



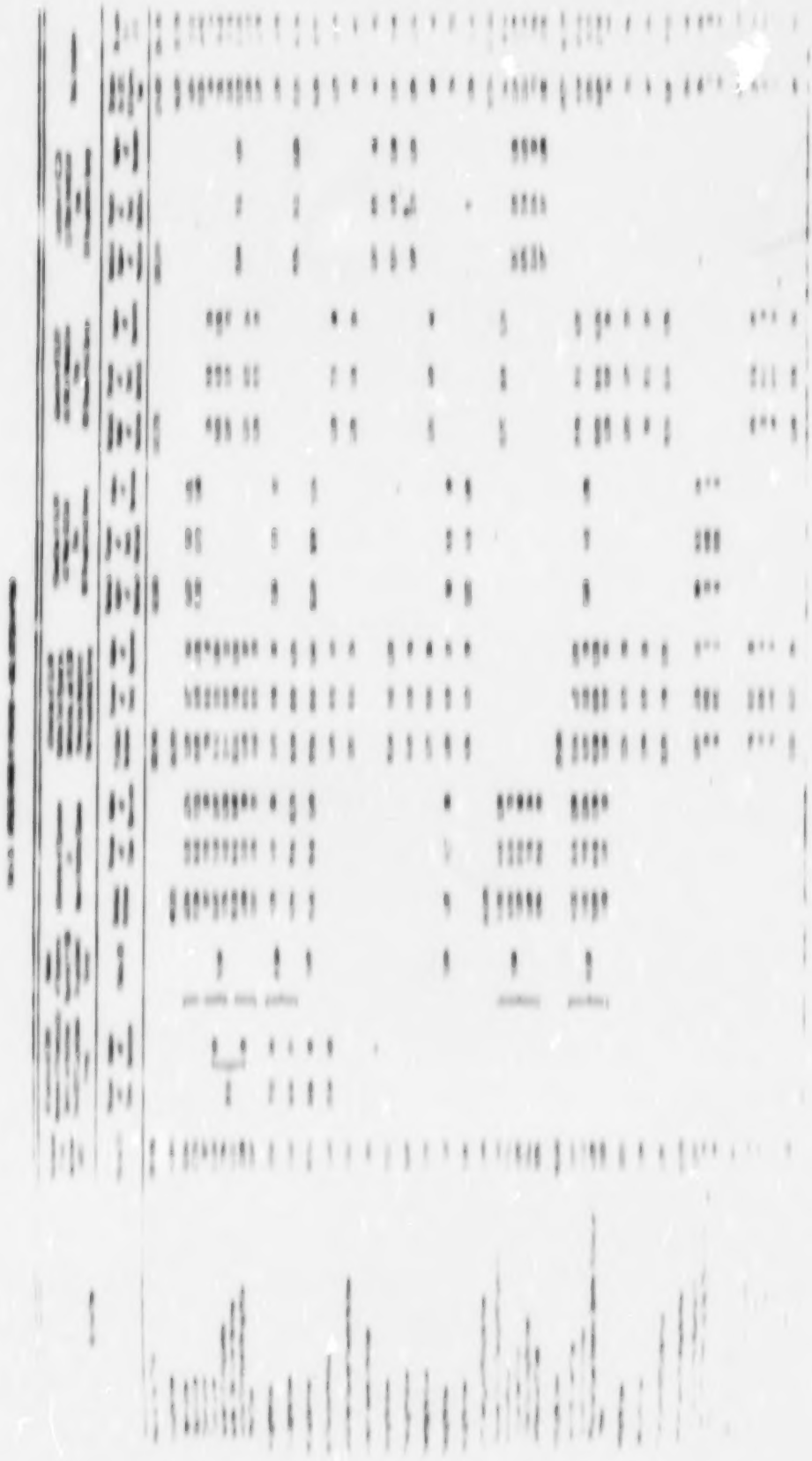
made proportionate to the numbers of machines (step 3) or residual machines (step 5).

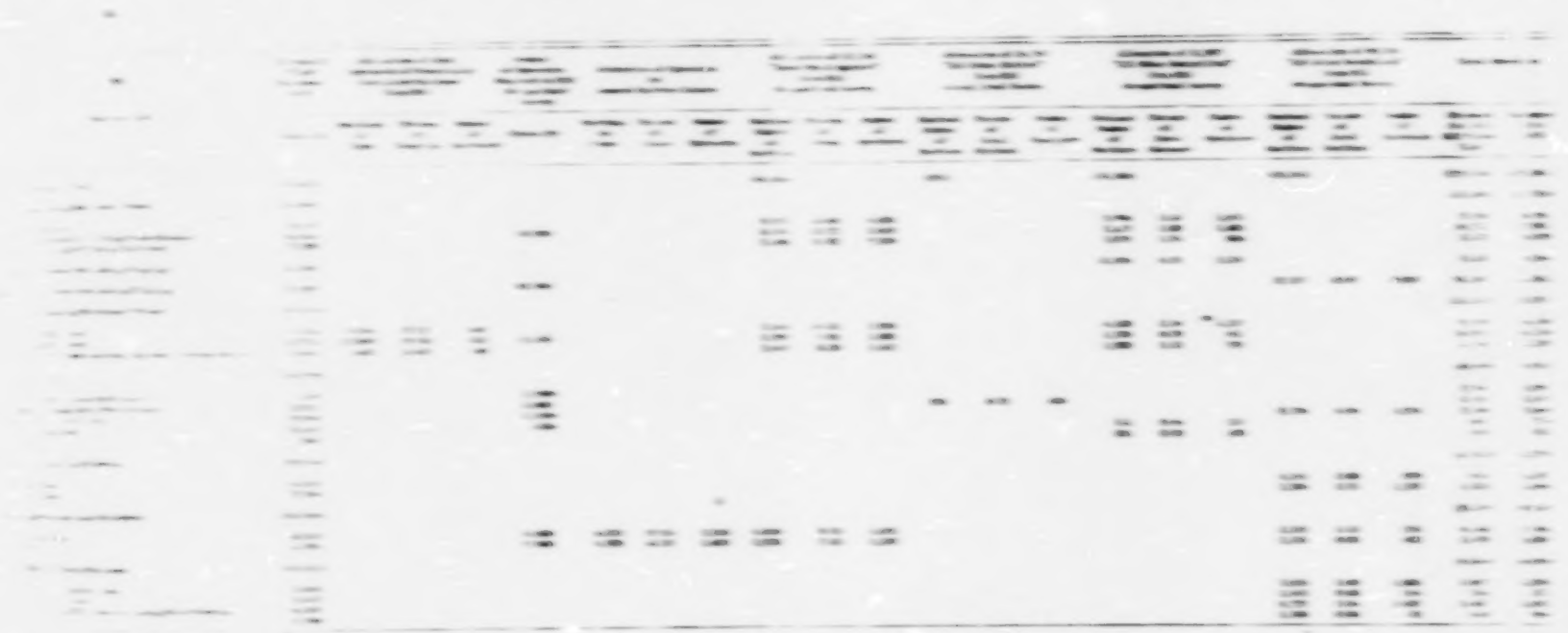
(7) Subtracting allocated operators (obtained in step 6) from machines (obtained in step 5) to obtain a new schedule of residual machines.

(8) Allocating operators identified as "Machine Tool Operator, Combination" and "Production Machinist" in the BLS Occupational Survey to the new schedule of residual machines (obtained in step 7). Allocating "Sheet Metal Workers" to metal forming machines in a similar manner.

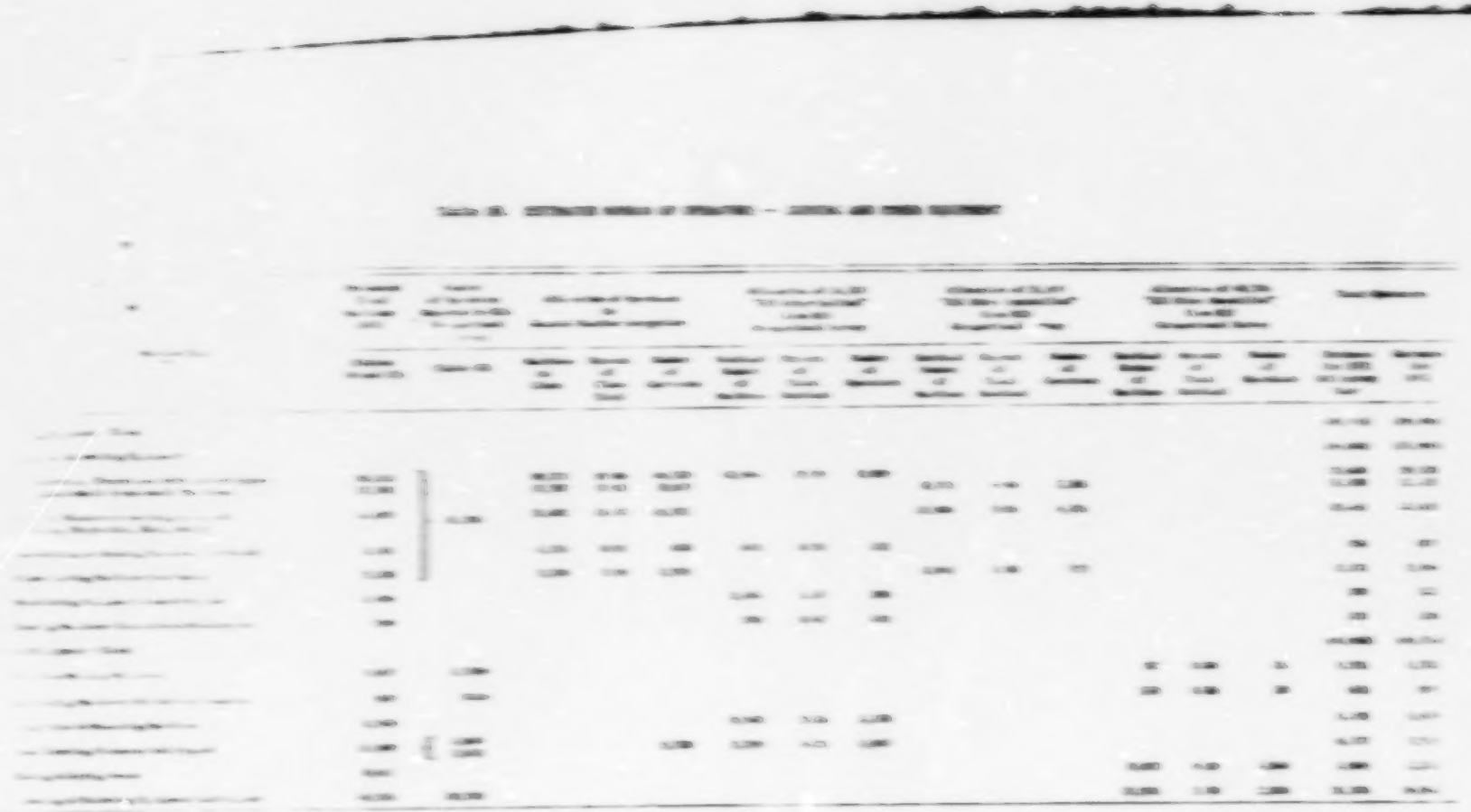
(9) Allocating to machines that portion of production workers reported in the BLS Occupational Survey as all other skilled, all other semiskilled, and all other nonskilled, which can reasonably be estimated to be operators of production machines. This was accomplished by: sorting production occupations between production machine operators and others as shown in Table 21; estimating skill levels for the identified occupations and listing numbers of production machine operators and others in appropriate skill level categories as shown in Table 21; computing summations of workers in each skill level for production machine operators and for others as shown in Table 21; computing percentage of workers in all other categories at each skill level to be allocated as production operators as shown in Table 22; computing numbers of production workers in all other categories at each skill level to be allocated to machines as shown in Table 23; allocating apportioned workers from all other categories at each skill level to the various residual numbers of machines as shown in Tables 16 through 18.

(10) Computing total numbers of production workers allocated to each machine type as shown in Tables 16 through 18.





Reproduced from best available copy.



Reproduced from
best available copy.

Table 20. DISTRIBUTION OF NUMERICALLY CONTROLLED MACHINES

Machine Type	Machines Reported in 1973 American Machinist Survey (Ref. 3)		Allocation of 2630 Operators from BLS Occupational Survey
	Number Specifically Identified by Machine Type[a] (Ref. 3)	Percent of Identified Total	
Turning	482	28.10	739
Boring	160	9.32	345
Drilling	246	14.34	377
Milling	183	10.66	280
Multifunction	403	23.48	618
Punch, Shear	242	14.10	371
Total	1,716	100.00	2,630

[a]Excludes those in "other" types not identified individually.

Reproduced from best available copy.

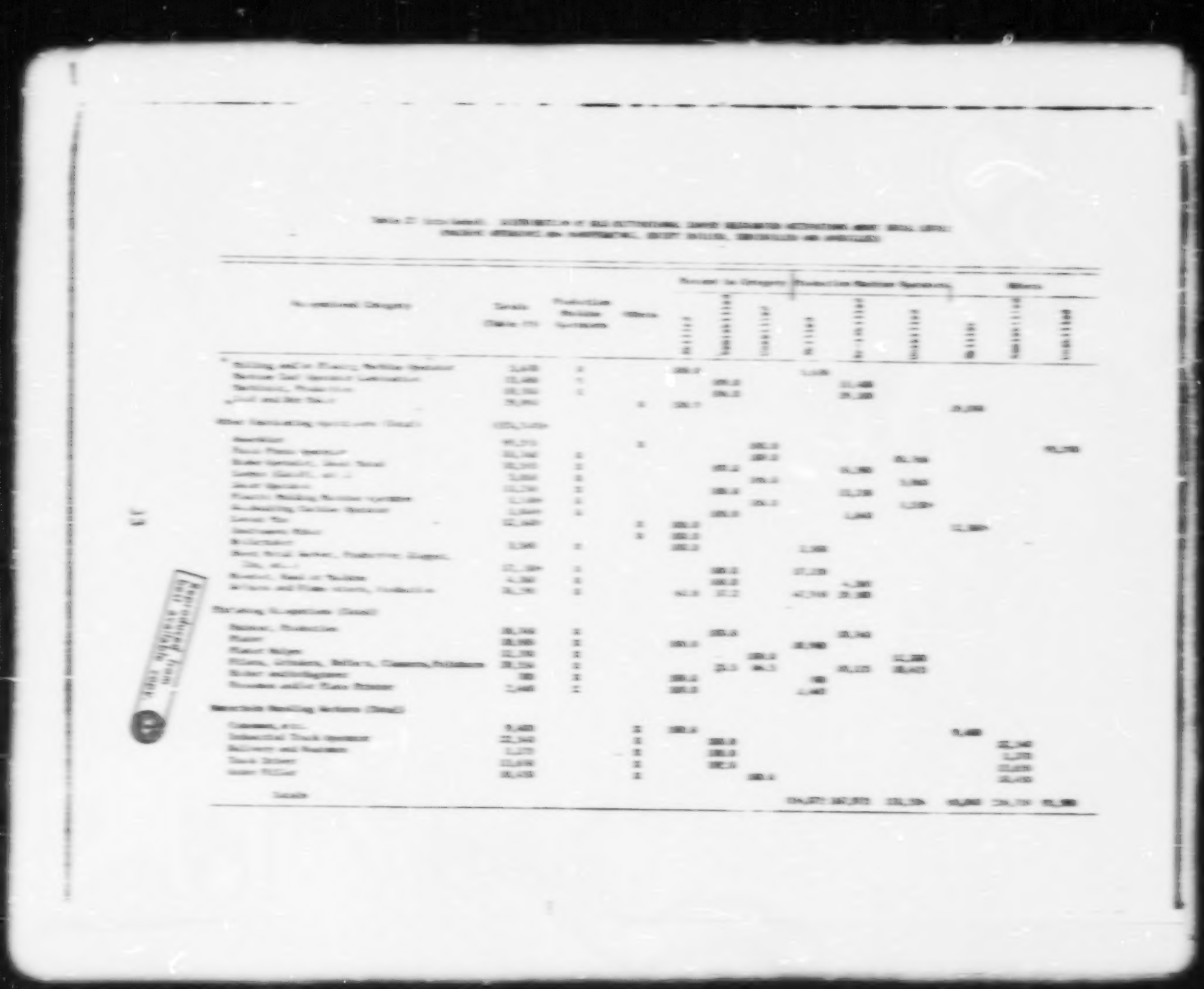


Table 22. RATIOS OF MACHINE OPERATORS TO OTHERS AT VARIOUS BLS ALL OTHER SKILL LEVELS

	Number	Percent of Total
Skilled		
Machine Operators	114,073	62.4
Others	68,840	37.6
Total	182,913	100.00
Semiskilled		
Machine Operators	167,973	59.0
Others	116,750	41.0
Total	284,723	100.0
Unskilled		
Machine Operators	131,534	57.9
Others	95,590	42.1
Total	227,124	100.0

Source: Table 19

Table 23. ALLOCATION OF BLS ALL OTHER SKILLED, SEMISKILLED AND UNSKILLED BETWEEN MACHINE OPERATOR AND NONOPERATOR OCCUPATIONS

	Level		
	All Other Skilled	All Other Semiskilled	All Other Nonskilled
Total in Class	39,690	88,130	84,380
Percent Machine Operators	62.4	59.0	57.9
Number Machine Operators	24,767	51,997	48,856

Source: Table 22

SECTION VIII

RANKING AND PRIORITIZING

Rankings of machine tools as industrial noise sources in the fabricated metal products industry are developed in accordance with three criteria in Tables 24 through 26. Each mode includes both the number of machine operators and the machine noise level as factors. Differences are in the treatment of the noise level, which is performed (1) as an increment above a selected threshold, in this case (dBA - 85) as shown in Table 24; (2) as an intensity factor, with an assumed value of 1.0 at 86 dBA and doubling with every 3 dBA increment above 86 dBA, as shown in Table 25; and (3) as dBA, shown in Table 26.

Table 24. MACHINES RANKED BY SUPERVISORS-REQUIRED NOISE OF OPERATORS

Machine Type	Noise Level (dBA)	Number of Machines	Number of Operators	$\frac{N}{P}$ (dBA-HP) / 1000
Mechanical Presses (except Forging)	99	121,887	102,812	7,439.4
Electric Arcwelding Equipment	97	107,685	71,963	863.6
Bending and Forming Machines - Power	104	26,701	25,753	489.3
Punching and Shearing Machines - Power	105	26,510	24,550	471.8
Drilling Machines	95	75,321	41,254	412.5
Turning Machines	92	89,795	51,378	359.6
Grinding Machines	93	60,892	42,253	338.0
Cutoff, Sawing and Filing Machines	103	45,819	17,460	314.3
Riveting Machines	117	11,300	9,126	292.0
Electric Resistance Welding Equipment	94	31,685	22,655	283.9
Forging Machines	105	14,266	9,926	198.5
Milling Machines	96	35,711	25,94-	176.8
Polishing and Buffing Machines	95	22,395	9,313	93.1
Hydraulic and Pneumatic Presses (except Forging)	101	11,806	3,594	57.5
Tapping Machines	94	10,240	3,699	33.3
Wire and Metal Ribbon Formers	98	9,735	2,556	33.2
Shaping Machines	99	6,361	2,6--	28.6
Flame Cutting Machines	92	5,238	3,744	26.2
Boring Machines	94	3,521	1,958	17.6
Other Metal Forming Machines (Roll Forming, etc.)	89	17,201	4,490	16.0
Planing Machines	110	1,292	573	14.3
Threading Machines	89	6,435	2,324	9.3
Special Way Type and Transfer Machines	94	2,817	862	7.6
Metallizing Equipment	102	1,464	322	5.5
Gear Cutting and Finishing Machines	84	1,089	348	-0.3
Electroetching Machines	80	969	975	-4.9

Table 25. MACHINES RANKED BY RELATIVE INTENSITY-REDUCED NUMBER OF OPERATIONS

Machine Type	dbh	F_n	Number of Machines	Operations E_p	$F_n \times E_p$ / 1000
Riveting Machines	117	1,290.30	11,306	9,126	11,734.4
Mechanical Presses (except Forging)	94	18.16	111,847	102,812	2,032.7
Punching and Shearing Machines - Power	105	80.64	26,519	23,550	1,899.1
Bending and Forming Machines - Power	104	64.80	26,701	25,753	1,636.7
Electric Arcwelding Equipment	97	12.70	107,865	71,963	1,359.7
Cutoff, Sawing and Filing Machines	103	32.30	45,819	17,460	887.8
Forging Machines	105	80.64	14,246	9,936	800.4
Drilling Machines	95	8.80	75,321	41,254	330.8
Grinding Machines	93	5.04	58,892	42,253	213.0
Turning Machines	92	4.00	89,795	51,378	205.5
Milling Machines	96	10.08	35,711	15,967	161.2
Planing Machines	110	256.00	1,292	573	146.7
Electric Resistance Welding Equipment	94	6.35	31,685	22,635	143.9
Hydraulic and Pneumatic Presses (except Forging)	101	32.91	11,006	3,594	125.8
Polishing and Buffing Machines	95	8.00	22,395	9,323	74.5
Shaping Machines	99	20.16	6,301	2,041	42.1
Wire and Metal Ribbon Formers	98	16.00	9,735	2,556	40.9
Tapping Machines	94	6.35	10,140	3,698	23.5
Flame Cutting Machines	92	4.00	5,238	3,744	15.0
Metallizing Equipment	102	40.32	1,484	322	13.0
Boring Machines	94	6.35	3,521	1,958	12.4
Other Metal Forming Machines	89	2.80	17,101	4,490	9.0
Special Way Type and Transfer Machines	94	6.35	2,017	842	5.3
Threading Machines	89	2.80	6,435	2,324	6.6
Gear Cutting and Finishing Machines	86	0.25	969	975	0.2
	84	0.63	1,089	348	0.2

Notes: F_n = 1.0 at 94 dbh; F_n doubles for each 3 dbh increase above 94 dbh.

Note: F_a = 1.0 at [illegible] dBA; F_a doubles for each 3 dBA incre[illegible] above [illegible] dBA.

Table 26. MACHINE TOOLS RANKED BY RECORD-WEIGHTED NUMBER OF OPERATORS

Machine Type	Noise Level (dBA)	Number of Machines	Number of Operators	$\frac{N \cdot dBA}{2}$ / 1000
Mechanical Presses (except Forging)	99	121,887	102,822	10,179.4
Electric Arc-welding Equipment	97	107,605	71,963	6,980.4
Turning Machines	92	89,795	51,339	4,726.8
Drilling Machines	95	75,321	41,254	3,919.1
Grinding Machines	93	88,892	42,253	3,929.5
Bending and Forming Machines - Power	104	36,301	25,753	2,678.7
Punching and Shearing Machines - Power	105	26,519	23,550	2,472.8
Electric Resistance Welding Equipment	94	31,685	22,655	2,129.6
Cutoff, Sawing and Filing Machines	103	45,829	17,460	1,798.4
Milling Machines	96	35,711	15,967	1,535.7
Riveting Machines	117	11,309	9,126	1,067.7
Forging Machines	105	14,266	9,926	1,042.2
Polishing and Buffing Machines	95	22,295	9,313	884.7
Other Metal Forming Machines (Bull Forming, etc.)	89	17,101	4,490	399.6
Hydraulic and Pneumatic Presses (except Forging)	101	11,006	3,594	363.0
Tapping Machines	94	10,360	3,698	347.6
Flame Cutting Machines	92	5,230	3,744	344.4
Wire and Metal Ribbon Formers	98	9,735	2,556	250.5
Shaping Machines	98	6,361	2,041	200.1
Threading Machines	89	6,435	2,334	196.8
Boring Machines	94	3,521	1,950	184.1
Special Way Type and Transfer Machines	94	2,017	842	79.1
Diecasting Machines	80	969	975	78.0
Planing Machines	110	1,392	573	63.0
Metallizing Equipment	102	1,484	322	32.8
Gear Cutting and Finishing Machines	84	1,089	348	29.2

SECTION 15

REFERENCES

1. Karplus, H. B. and Romvallet, G. L., "A Noise Survey of Manufacturing Industries", Industrial Hygiene Quarterly, December 1953.

2. 11th American Machinist Inventory of Metalworking Equipment, American Machinist, McGraw-Hill, Inc., New York, October 29, 1973.

3. 10th American Machinist Inventory of Metalworking Equipment, American Machinist, McGraw-Hill, Inc., New York, 1968.

4. Occupational Employment, Metal Cans Industry, June 1971, Report 430-19, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C.

5. Occupational Employment, Cutlery, Hand Tools and Hardware Industry, June 1971, Report 430-112, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., November 1974.

6. Occupational Employment, Plumbing and Heating, Except Electric, Industry, June 1971, Report 430-74, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., September 1974.

7. Occupational Employment, Fabricated Metal Products Industry, June 1971, Report 430-77, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., November 1974.

8. Occupational Employment, Screw Machine Products Industry, June 1971, Report 430-75, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., January 1975.

9. Occupational Employment, Metal Stampings Industry, June 1971, Report 430-83, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., January 1975.

10. Occupational Employment, Coating, Engraving and Allied Services Industry, June 1971, Report 430-76, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., September 1974.

11. Occupational Employment, Miscellaneous Fabricated Wire Products Industry, June 1971, Report 430-84, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., August 1974.

12. Occupational Employment, Miscellaneous Fabricated Metal Products Industry, June 1971, Report 430-85, U.S. Department of Commerce, Bureau of Labor Statistics, Washington, D.C., September 1974.

APPENDIX

INDUSTRY MACHINE NOISE LEVEL DATA

REFERENCES FOR MACHINERY NOISE DATA

1. NTID300.1, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances, U.S. Environmental Protection Agency, December 31, 1971.

2. Miller, R. K., You Can Reduce Plant Noise, Food Engineering, March 1973.

3. Cannon, R. H., Noise Reduction for Equipment Operations Underground, Mining Congress Journal, March 1972.

4. Satek, J. E., Underground Noise Control: The New Challenge, Coal Age, December 1971.

5. Lamonica, J. A., et al, Noise in Underground Coal Mines, RI 7550, USDI, Bureau of Mines, August 1971.

6. Willoughby, R. A. and Parker, E., Reducing Pneumatic Tool Noise, Plant Engineering, September 6, 1973.

7. Machinery Noise Data Sheets

8. Karplus, H. and Bonvallet, G. L., A Noise Survey of Manufacturing Industries, American Industrial Hygiene Association Quarterly, v 14 n 4, December 1953.

9. Report Number 2671, Impact on Noise Control at the Workplace, Bolt Beranek and Newman, October 29, 1973.

10. Noise from Power Plant Equipment, The Institute of Mechanical Engineers, Proceedings 1966-1967, v 181, part 1G, September 21-23, 1966 (British Publication).

SIC Code 16 - Construction Other than Building Construction

Machine	Overall Level dBA	Ref. Number
Bulldozers	80[1] (104)[2]	1
Scrapers	88[1] (112)	1
Trucks (Construction)	91[1] (115)[2]	1
Pavers Self-propelled	89[1] (113)[2]	1
Backhoes	85[1] (109)[2]	1
Compactors		
Graders	85[1] (109)[2]	1
Frontloaders	79[1] (103)[2]	1
Shiploaders		
Concrete Mixers	85[1] (109)[2]	1
Conveyors		
Vibrators	76[1] (100)[2]	1
Concrete Pumps	82[1] (106)[2]	1
Rock Crushers		
Cranes	83[1] (107)[2]	1
Pile Drivers	101[1] (125)[2]	1
Drop Hammers		
Pneumatic Tools	85[1] (109)[2]	1
Off-Highway Tractors	80[1] (104)[2]	1
Draglines		
Shovels		
Street Sweeper		
Rock Drill	98[1] (122)[2]	1
Derrick	88[1] (112)[2]	1
Clamshell		
Ripper		
Pipe Layer		
Roller		
Trencher		
Forklift		

SIC Code 16 (concluded) - Construction Other than Building Construction

Machine	Overall Level dBA	Ref. Number
Travel Lift		
Compressor	81[1] (105)[2]	1
Generator	78[1] (102)[2]	1
Jackhammer	88[1] (112)[2]	1
Stripping Pump		
Well-Point Pump		

[1] SPL measured at 50 ft from machine.

[2] SPL adjusted to 3 ft by adding 6 dBA for distance halving.

SIC Code 20 - Food and Kindred Products

Machine	Overall Level dBA	Ref. Number
Bottling and Packaging Machinery	93[2]	2
Washing and Sterilising Equipment		
Pasteurisers		
Homogenisers	93[2]	3
Ice Cream Freezers		
Butter and Cheese Processing Machinery		
Dry Milk Processing Machinery		
Slicers		
Choppers	93[1]	6
Grinders		
Dicers		
Mixers		
Tenderisers		
Ovens		
Continuous Breadmaking Equipment		
Wrapping Machines		
Bottling Equipment	97[2]	7
Meat and Poultry Processing Equipment		
Fruit and Vegetable Canning Machinery		
Flour and Grainmill Machinery		
Sugar Plant Machinery		
Oilseed Crushing and Extracting Machinery		
Bottle Washers and Sterilisers	93[2]	2
Uncasers and Casers		
Capping Machines		
Packing and Packaging Machines		
Carbonators		
Filling and Labeling Machines		
Holding Machine	86[1]	6
Peanut Blanching Machine	89[1]	6
Bottle Filler	96[2]	2

SIC Code 20 (concluded) - Food and Kindred Products

Machine	Overall Level dBA	Ref. Number
Lift Truck	91[2]	7
Peanut Blsing Machine	95[2]	8
Salt Pulverizer	95[2]	8
Vibrating Conveyor	91[2]	8
Metal Conveyor for Bottles	94[2]	8
Pecan Shell Cracker	101[2]	8
Paper Container Shear	100[2]	8
Candy Cane Twister	95[2]	8
Mash Tank	100[2]	8
Refrigeration Compressor	100[2]	8
Candy Print Machine	97[2]	8
Bodymaker	104[2]	7
Assembly Line (Can)	99[2]	7
Automatic Can Fabricating Machine	98[2]	7

[1]SPL measured 3 to 5 ft from machine.

[2]SPL measurement distance not specified.

SIC Code 21 - Tobacco Manufacturers

Machine	Overall Level dBA	Ref. Number
Conveyors		
Driers		
Fans		
Cutting Equipment		
Washing Equipment		
Packaging Equipment		

SIC Code 22 - Textile Mill Products
(Includes Apparel and Other Finished Products, SIC 23)

Machine	Overall Level dBA	Ref. Number
Cleaning and Opening Machinery		
Carding and Combing Machines		
Drawing and Roving Frames		
Spinning Frames	82[1]	8
Twisting Frames	83[1]	8
Yarn Preparing Machines	97[1]	8
Power Looms	102[1]	8
Knitting Machines		
Bleaching, Dyeing and Finishing Machinery	100[2]	8
Drying Machinery		
Reducing Machines	96[1]	8
Reducer Transfer Machines	89[1]	8
Combing Machines	95[1]	8
Pin Drafters	92[1]	8
Preparers	90[1]	8
Tack Driver	116[2]	7

[1] SPL measured 3 to 5 ft from machine.
[2] SPL measurement distance not specified.

SIC Code 24 - Lumber and Wood Products
(Includes Furniture and Fixtures, SIC 25)

Machine	Overall Level dBA	Ref. Number
Veneer and Plywood making Machinery		
Saws	111[1]	8
Jointers	88[1]	8
Matchers		
Molders	99[1]	8
Mortisers		
Shapers	89[1]	8
Tenoners	95[1]	8
Lathes	98[1]	8
Planing Machines	108[1]	8
Surfacing Machines	98[1]	8
Drills		
Barkers	91[1]	8
Slashers	97[1]	8
Sanders	85[1]	8

[1] SPL measured 2 to 3 ft from machine.

SIC Code 26 - Paper and Allied Products

Machine	Overall Level dBA	Ref. Number
Barkers	91[1]	8
Chippers		
Knotters		
Splitters		
Chipscreens		
Grinders		
Deckers		
Digesters		
Beaters		
Jordans		
Calenders	93[1]	8
Fourdriniers		
Bagmaking Machines		
Corrugated Boxmaking Machines	97[1]	8
Box, Carton and Shipping Containermaking Machines	85[1]	8
Toilet Roll and Napkinmaking Machines		
Slashers	97[1]	8
Pulp Preparation Machine	83[1]	8
Mixers	94[1]	8
Paper Machines	88[1]	8
Pumps	93[1]	8

[1]SPL measured 3 to 5 ft from machine.

SIC Code 27 - Printing, Publishing and Allied Products

Machine	Overall Level dBA	Ref. Number
Lithographic Printing Presses		
Newspaper Presses	93[1]	8
Business Form Presses		
Commercial Presses		
Gravure		
Flexographic		
Typesetting Machinery	81[1]	8
Saddle Binding Equipment		
Perfect and Hard Case Binding Equipment		
Electrotyping Machines		
Stereotyping Machines		
Paper Cutting Machines		
Collating Machines	90[1]	8
Gathering Machines		
Printer-Slotters	98[1]	8
Stitchers	85[1]	8
Folders	94[1]	8
Shears	103[1]	8
Ink Mills	91[1]	8
Cleaning Tanks	87[1]	8
Newsprint Rewinders	85[1]	8
Air Ejectors	81[1]	8

[1] SPL measured 3 to 5 ft from machine.

SIC Code 28 - Chemical and Allied Products
(Includes Rubber and Miscellaneous Plastic Products SIC 30)

Machine	Overall Level dBA	Ref. Number
Ink Mills	93[1]	8
Pigment Mills	91[1]	8
Pebble Mills	80[1]	8
Mixers	80[1]	8
Drum Cleaners	78[1]	8
Five-Roll Mills	97[1]	8
Hammer Mills	98[1]	8
Compounding Rolls	93[1]	8
Ball Mills	99[1]	8
Fabric Coaters	81[1]	8
Rewind, Fabric Seaming	80[1]	8
Rotary Kilns	82[1]	8
Rubber Mills	86[1]	8
Tread Tubers	90[1]	8
Curing Presses	94[1]	8

[1]SPL measured 3 to 5 ft from machine.

Machine	Overall Level dBA	Ref. Number
Rotary Drilling Surface Equipment		
Rotary Drilling Subsurface Equipment		
Cable Tool Drilling Machinery		
Flowing Well Equipment		
Rod Lifting Machinery		
Pumping Units		
Oil and Gas Separating, Metering and Treating Equipment		
Well Surveying Machinery		
Crushing, Pulverizing and Screening Machinery	86[2]	3
Drills	110[2]	3
Cutting Machines	96[1]	5
Longwall Mining Machines		
Gathering Arm Loading Machines	99[1]	5
Slusher Hoists Loading Machines		
Continuous Mining Machines	97[1]	5
Borers		
Rippers		
Shuttle Cars (Loading)	93[1]	5
Mine Cars		
Floatation Machines		
Wet Cyclones		
Centrifugal Driers		
Scrubbers		
Thermal Driers		
Feeders		
Grinding Mills		
Screens		
Shakers		
Roof Bolter	112[1]	4
Coal Cleaning Equipment	103[1]	7
Electromechanical Vibrator	98[2]	7

[1] SPL measured 3 to 5 ft from machine.

[2] SPL measured distance not specified.

SIC Code 31 - Leather and Leather Products

Machine	Overall Level dBA	Ref. Number
Fleshing Machines	89[1]	8
Hair Driers	88[1]	8
Lime Mixing Tubs	77[1]	8
Setting Out Machines	103[1]	8
Splitting Machines	85[1]	8
Coloring Drums	90[1]	8
Plating	81[1]	8
Seasoning Machines	80[1]	8
Spraying Machines	78[1]	8
Measuring Machines	77[1]	8

[1]SPL measured 2 to 5 ft from machine.

SIC Code 32 - Stone, Clay and Glass Products

Machine	Overall Level dBA	Ref. Number
Clay Crushers	92[1]	8
Clay Tile Extrusion Machines	82[1]	8
Packing Machines	86[1]	8
Bottle Forming Machines	98[1]	8
Mixers	93[1]	8
Pneumatic Chippers	84[1]	8
Cutoff Saws	89[1]	8
Stone Planers	98[1]	8
Cranes	84[1]	8
Stone Saws	99[1]	8
Concrete Aggregate	89[1]	8
Clay Tile Kiln (Unloading)	97[1]	8
Eyeglass Automatic Assembly Machines	96[2]	7
Top Profiler	105[2]	7
Side Profiler	95[2]	7

[1]SPL measured 3 to 5 ft from machine.

[2]SPL measurement distance not specified.

SIC Code 33 - Primary Metal Industries

Machine	Overall Level dBA	Ref. Number
Grinders	90[1]	8
Pneumatic Chippers	117[1]	8
Furnaces (Ingot Heating)	93[1]	8
Furnaces (Oil Heating)	93[1]	8
Wood Planers	107[1]	8
Friction Saws	107[1]	8
Shakeouts	103[1]	8
Pneumatic Rams	84[1]	8
Tumblers	99[1]	8
Pushup Machines	99[1]	8
Core Blowers	116[1]	8
Core Draw Vibrators	108[1]	8
Air Hoists	108[1]	8
Electric Furnaces	96[1]	8
Sand Slingers	96[1]	8
Jolt Squeeze Machines	97[1]	8
Crucible Heaters	81[1]	8
Roughing Mills	102[1]	8
Levelers	90[1]	8
Decoilers	116[1]	8
Annealing Furnaces	93[1]	8
Lectromelt Furnaces	99[1]	8
Open Hearth Furnaces	80[1]	8
Scarfing Equipment	86[1]	8
Bloomer Mills	90[1]	8
Strip Mills	97[1]	8
Conveyors	96[1]	8
Forging Hammers	109[1]	8
Coke Ovens	93[2]	9
Sinter Plants	100[2]	9
Blast Furnaces	93[2]	9

SIC 33 (concluded) - Primary Metal Industries

Machine	Overall Level dBA	Ref. Number
Basic Oxygen Furnaces	99[2]	9
Soaking Pits	98[2]	9
Rolling Mills	95[2]	9
Continuous Picklers	95[2]	9
Pipe Mills	96[2]	9
Wire Drawing	95[2]	9
Nail Mills	98[2]	9
Shakeout	106[1]	7
Pneumatic Chipper	110[1]	7
Pushup Machine	103[1]	7
Jolt Squeeze Machine	100[1]	7
Pneumatic Ram	90[1]	7
Core Blower	116[1]	7
Stand Grinder	96[1]	7
Premix Burner	94[1]	7
Core Room	125[2]	7
Knockout Bench	114[2]	7
Tumbling Barrels	104[1]	7
Molding Area	96[2]	7
Grinding Area	98[2]	7
Electric Furnace	105[1]	7
Air Hoist	112[1]	7
Sand Slinger	102[1]	7
Electric Furnace	115[1]	7

[1] SPL measured 3 to 5 ft from machine.

[2] SPL measurement distance not specified.

SIC Code 34 - Fabricated Metal Products

Machine	Overall Level dBA	Ref. Number
Boring Machines	97[1]	8
Drilling Machines	98[1]	8
Gear Cutting Machines	88[1]	8
Grinding Machines	106[1]	8
Polishing Machines	95[1]	8
Lathes	107[1]	8
Milling Machines	101[2]	7
Saws	107[1]	8
Broaching Machines	94[2]	7
Planers	108[2]	7
Shapers	99[1]	7
Cutoff Machines	101[1]	8
Tapping Machines	94[1]	8
Threading Machines		
Automatic Chucking Lathes		
Screw Machines	94[1]	7
Station and Transfer Machines	94[2]	7
Electric Discharge Machines		
Electrochemical Machines		
Honing and Lapping Machines		
Welding Machines	82[1]	8
Punches	98[1]	8
Shears	97[1]	7
Bending Machines	92[1]	8
Forming Machines	108[1]	8
Mechanical Presses	107[1]	8
Hydraulic Presses	100[2]	7
Pneumatic Presses	101[1]	8
Extrusion Presses		
Headers and Upsetters	106[1]	8

SIC Code 34 (continued) - Fabricated Metal Products

Machine	Overall Level dBA	Ref. Number
Gaging Machines	112[2]	7
Gear and Spline Rolling Machines	89[1]	8
Thread Rolling Machines	89[1]	8
Marking Machines		
Riveting Machines	120[2]	7
Diecasting Machines	80[2]	7
Impact Wrenches		
Power Driven Hand Tools	95[2]	8
Drop Hammers	103[1]	7
Sand Blast Machines	121[1]	8
Vibrators	104[1]	8
Cutoff Saws	113[1]	7
Pin Machines	104[2]	7
Automatic Spot Welding Machines	96[2]	7
Pneumatic Grinder	106[1]	7
Wire Drawing Insulating Machine	93[1]	7
Wire and Cable Insulating Machine	101[2]	7
Braiding Machine	103[1]	7
Twisting Machine	96[2]	7
Metallising Process Machine	101[1]	7
Horizontal Boring Machine	91[2]	7
Chippers	116[2]	7
Deburring Machine	107[1]	7
Head Spinner	95[1]	7
Screwplate Press (300 Ton)	99[2]	7
Cold Header	97[2]	7
Staple Forming Machine	101[2]	7

SIC Code 34 (concluded) - Fabricated Metal Products

Machine	Overall Level dBA	Ref. Number
Punch presses	100[1]	7
Router	113[1]	7
Ball Mills	100	7

[1] SPL measured 2 to 5 ft from machine.
[2] SPL measurement distance not specified.

SIC Code 36 - Electrical and Electronic Machinery

Machine	Overall Level dBA	Ref. Number
Drilling Machines	98[1]	8
Grinding Machines	106[1]	8
Polishing Machines	95[1]	8
Saws	107[1]	8
Tapping Machines	96[1]	8
Threading Machines		
Welding Machines	82[1]	8
Punches	98[1]	8
Shears	93[1]	8
Bending Machines	92[1]	8
Forming Machines	108[1]	8
Riveting Machines	117[1]	8
Power Driven Hand Tools	102[2]	8

[1] SPL measured 3 to 5 ft. from machine.

[2] SPL measurement distance not specified.

SIC Code 37 - Transportation Equipment

Machine	Overall Level dBA	Ref. Number
Riveting Machines	133[1]	8
Drills	88[1]	8
Saws	107[1]	8
Routers	86[1]	8
Welding Machines	82[1]	8
Punches	98[1]	8
Shears	93[1]	8
Bending Machines	92[1]	8
Forming Machines	108[1]	8
Mechanical Presses	101[1]	8
Hydraulic Presses	100[2]	7
Pneumatic Presses	101[1]	8
Impact Wrenches		
Power Driven Hand Tools	95[2]	8

[1] SPL measured 2 to 3 ft from machine.
[2] SPL measurement distance not specified.

SIC Code 49 - Utilities

Machine	Overall Level dBA	Ref. Number
Fans	110[2]	10
Gas Turbines	90[2]	10
Oil Burners	85[2]	10
Diesel Engines	100[2]	10
Rotary Blowers	120[2]	10
Turbo-Alternators	85[2]	10
Feed Pumps	90[2]	10
Transformers	60 to 100[2] (Size Dependent)	10
Steam Turbine	105	7

[2]Noise measurement distance not specified.